A FURTHER REPORT ON THE TRANSMISSION OF HUMAN TRYPANOSOMES BY *GLOSSINA MORSITANS*, WESTW.

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CONTENTS

I. INTRODUCTION

In an earlier report,* details were given of a number of experiments on the transmission of *Trypanosoma rhodesiense* (Stephens and Fantham) by laboratory-bred and 'wild' *Glossina morsitans* (Westw.), on the transmission of an identical organism by naturally-infected tsetse flies of that species, and on the occurrence, in game, of a trypanosome indistinguishable from the human parasite. As a result of these experiments, the following conclusions were drawn:—

1. The human trypanosome, in the Luangwa Valley, is transmitted by *Glossina morsitans* (Westw.).

2. *Glossina morsitans*, in nature, has been found to transmit the human trypanosome.

* Kinghorn and Yorke, Annals Trop. Med. and Parasitol., VI, pp. 1-23, March, 1912.

3. Certain species of game have been found to be infected with the human trypanosome.

Since writing that paper, additional work has been done along similar lines, and the results obtained have served to strengthen the validity of the conclusions at which we had previously arrived. These experiments are given below, and bring the investigations on the human trypanosome up to the date on which the Commission left the Luangwa Valley for the Congo-Zambesi watershed.

As the methods pursued have been precisely similar to those we have already described, it will be unnecessary to make further reference to them.

It may be noted that the earlier transmission experiments were made during the dry and during the commencement of the wet seasons, while those now given were carried out during the rains proper. The two series serve, therefore, to demonstrate that *Glossina morsitans* is capable of transmitting the human trypanosome during the whole year. A brief summary of the chief meteorological observations is given in Table 1.

TABLE 1.—Meteorological observations at Nawalia, N. Rhodesia, 12° 25′ S., 32° 2′ E., altitude 2,100 feet (approximate).

1911–1912.	External shade temperature mean	Laboratory temperature mean	Relative humidity %	Rainfall inches	Number days on which rain fell
June............	67·2	—	48·6	0	—
July	68·7	67·4	45·7	0	—
August	73·3	71·2	35·8	0	—
September ..	77·5	71·5	*31·5	0	—
October	86·1	84·5	*31·8	0·26	2
November ...	87·1	84·6	41·1	1·61	8
December ...	82·3	79·6	69·1	8·54	20
January	80·6	78·4	77·7	14·97	16
February ...	79·2	77·1	73·8	5·55	16
March	79·0	72·0	62·5	5·10	6
April (to 9th)	—	—	—	0·01	1
				36·04	69

* Approximate.

II. TRANSMISSION OF THE TRYPANOSOME

A. By Laboratory-Bred *Glossina morsitans*

Experiment 1. Commenced December 29th, 1911, with twenty laboratory-bred flies.

These flies were infected directly from a patient in whose peripheral blood three trypanosomes per field (Zeiss Oc. 4, Obj. DD) were seen. They were afterwards fed daily for sixty-five days on a series of healthy monkeys, none of which became infected. From the sixty-seventh to seventieth day of the experiment, the seven flies then alive were fed on a guinea-pig heavily infected with the human trypanosome, and were then fed for a further period of thirty days on a clean monkey. This did not become infected.

Experiment 2. Commenced January 12th, 1912, with twenty-three laboratory-bred flies.

These were fed for four days on a patient showing, on an average, one trypanosome to three fields in the peripheral blood, and afterwards on healthy monkeys, as indicated in Table 2.

Table 2.—Showing transmission of human trypanosome by laboratory-bred *Glossina morsitans*.

Day	Animal	Number flies fed	Result	Remarks
0—3rd	Patient	23	—	
4th	—	—	—	Flies starved
5th—8th	Monkey No. 237	22	Negative	
9th—12th	,, ,, 238	22	,,	
13th—16th	,, ,, 240	22	,,	
17th—20th	,, ,, 254	20	Infection	
21st—23rd	,, ,, 237	18	—	Died on 24th day
24th	,, ,, 240	17	Infection	
25th—29th	,, ,, 260	9	Negative	Flies divided into two groups
	,, ,, 261	9	Infection	
30th—60th	,, ,, 272	16-0	Negative	Infected fly did not feed

On February 20th, the twenty-ninth day of the experiment, the fly numbered D 18 died, and on dissection was found to show a massive intestinal infection of trypanosomes. Unfortunately the fly had been dead for some hours before it was examined, and it was found impossible to dissect out the salivary glands. The whole abdominal contents, therefore (gut and glands), were crushed up in normal saline solution and inoculated into a healthy monkey, which became infected five days later. The disease ran a typical course.

None of the other flies—dissected as they died—were found to harbour trypanosomes in the proboscis, gut, or salivary glands.

In this instance the time which elapsed from the date of the *first* infective meal until the date on which the fly became capable of transmitting the trypanosome (allowing five days for the incubation period in the monkey) was nineteen days.

B. By 'Wild' *Glossina morsitans*

Experiment 3. Commenced January 12th, 1912, with forty-two freshly-caught flies.

After being fed for one day on a monkey infected with the human trypanosome, and showing numerous parasites in the peripheral blood, the flies were fed on a clean monkey for nine days. They were then starved for one day, and subsequently allowed to feed on clean monkeys and rats from the eleventh to the thirty-third day. None of these animals became infected. The flies were dissected as they died, and while trypanosomes were found in the gut and proboscis of several, in no instance was an infection of the salivary glands observed.

Experiment 4. Commenced January 12th, 1912, with forty-two freshly-caught flies.

The details of this experiment are exactly similar to those of Experiment 3, with the exception that from the first to the ninth day the flies were fed on a native fowl instead of on a monkey. They were starved on the tenth day, as before, and afterwards fed on clean monkeys and rats from the eleventh to the thirty-eighth day. None of these animals became infected. Trypanosomes were found in the proboscis and gut of several of the flies, when dissected, but in no case were the salivary glands implicated.

Experiment 5. Commenced February 14th, 1912, with one hundred and four freshly-caught flies.

On the 13th of February, the flies were fed on a healthy monkey which did not become infected, thus excluding the possibility that they were already infected with the trypanosome. On the four succeeding days they were fed on a guinea-pig infected with the human trypanosome, and showing numerous parasites in the peripheral blood, and afterwards on clean monkeys, as indicated in Table 3.

TABLE 3.—Showing transmission of the human trypanosome by freshly-caught *Glossina morsitans*.

Day	Animal	Number flies fed	Result	Remarks
4th				Flies starved
5th—10th	Monkey No. 269	98	Negative	
11th				Flies starved
12th	,, ,, 269	64	,,	
13th—27th	,, ,, 280	41	,,	Died on 28th day
13th—29th	,, ,, 281	47	Infection	Flies divided into two groups, A and B
28th—29th	,, ,, 286	33	Negative	Group A, only, fed
30th	,, ,, 269	17	Infection	Group B, only, fed
30th—38th	,, ,, 300	10	Negative	Flies of group A divided into 3 sub-groups, A1, A2, and A3
30th—40th	,, ,, 301	10	,,	
30th—40th	,, ,, 302	12	,,	
31st—33rd	,, ,, 303	12	,,	Flies in group B divided into 3 sub-groups, B1, B2, and B3
31st—37th	,, ,, 304	11	Infection	
31st—34th	,, ,, 305	12		Monkey escaped on 35th day
34th—39th	,, ,, 310	11	Negative	Sub-group B1 fed
35th—52nd	,, ,, 315	12	,,	Sub-group B3 fed
39th—52nd	,, ,, 300	15	,,	Sub-groups A1 and B2 fed
41st—52nd	,, ,, 301	28	,,	Sub-groups A2, A3, and B1 fed

The insects were dissected as they died, but only in one, the infective fly, was an infection of the salivary glands observed, though in a considerable number an infection of the proboscis and gut was found.

The duration of the developmental cycle of the trypanosomes in the fly would appear to be twenty-five days in this experiment. The flies were fed for the *first* time on the infected guinea-pig on February 14th, and the first monkey became infected on March 15th, thirty days later. The average incubation period of the disease in monkeys is five days, so that the cycle took twenty-five days to complete.

It may be pointed out, however, that all our estimations of the latent periods of the trypanosomes in the flies represent the probable durations only. Although the average incubation period in monkeys is five days, this has been found to vary from three to eight days, and it is possible, therefore, that the cycle may have been slightly shorter, or longer, in any one instance.

Moreover, a further source of error is introduced in those experiments in which the flies were fed on an infected animal for more than a single day. It has yet to be determined whether only a definite percentage of flies is inherently capable of transmitting the disease, or whether *any* fly will do so, provided that it has an opportunity of feeding on an infected animal at some particular time during its existence. If the latter alternative be correct, the peculiar factors governing their infectability have still to be ascertained. Assuming the first view to be correct, then the latent period of the trypanosomes in the flies must date from the *first* occasion on which the insects were fed on the infected animal, while, if the second be correct, the latent period may date from *any* of the meals on the infected animal.

In our earlier paper, the latent periods of the parasites in the flies were given as eleven, thirteen, and fifteen days, while in the present series they are nineteen and twenty-five days.

A synopsis of all the transmission experiments reveals some interesting features.

As will be seen, all (three in number) the experiments made during the dry, and commencement of the rainy seasons, were successful, while only two of the five carried out during the rains proper were positive. Further, in the rainy season, only 3 of 231 flies proved to be transmitting the trypanosome, a percentage of 1·29, as against at least 4, and probably 8, in the dry season. The larger figure depends on the number of salivary gland infections observed.

Although some hundreds of *Glossina morsitans* have been dissected, a salivary infection has been found only in those flies which proved to be transmitting the human trypanosome.

Superficially, therefore, the meteorological conditions would appear to have a considerable influence on the development of the human trypanosome in *Glossina morsitans*, but while we consider these findings of sufficient importance to be emphasised, we cannot definitely state that such is the case, as our experiments are too few in number, and have been carried out during a single dry and wet season only.

TABLE 4.—Synopsis of transmission experiments with laboratory-bred and 'wild' *Glossina morsitans.*

Experiment	Date on which started	Season	Number flies used	Variety of flies used	Result
1	20/8/11	Dry	26	Laboratory-bred	Infection
2	14/11/11	Comm't rains	16	,,	,,
3	14/11/11	,,	57	'Wild'	,,
4	29/12/11	Rainy	20	Laboratory-bred	Negative
5	12/1/12	,,	42	'Wild'	,,
6	12/1/12	,,	42	,,	,,
7	12/1/12	,,	23	Laboratory-bred	Infection
8	13/2/12	,,	104	'Wild'	,,

Amongst the bred flies only, 3 of 85 transmitted the parasite, a percentage of 3·52, as compared with 4·76, the figure given in our former report.

In none of the transmission experiments have we observed an instance of 'late infection,' although the majority of them were continued for periods varying from forty to seventy days. Both sexes have been found to be capable of transmitting the trypanosome.

As mentioned above, an infection of the salivary glands was found only in those flies which had transmitted the parasite, and the limited data at our disposal would indicate that the development of *Trypanosoma rhodesiense* in *Glossina morsitans* is strictly comparable to that of *Trypanosoma gambiense* in *Glossina palpalis*, that is, the trypanosomes, on being ingested by the flies, very quickly lose their virulence and do not regain it for a variable period, after which they are found both in the gut and salivary glands. In one instance only, have parasites been seen in the proboscis of a bred *Glossina morsitans*, and this in a fly which was not transmitting the organism. They were few in number and were not collected in the rosettes usually found in the proboscis of tsetse flies infected, in nature, with other varieties of trypanosomes. The evidence which we possess would indicate that the infection of the proboscis of this fly was fortuitous and not particularly related to the regular transmission of the human trypanosome.

III. TRANSMISSION OF THE TRYPANOSOME, IN NATURE, BY *GLOSSINA MORSITANS*

From day to day varying numbers of 'wild' tsetse flies were fed on clean monkeys and in certain cases (5), the animals became infected with a trypanosome indistinguishable from the human one. The identity of the parasites isolated in this manner was checked by a careful study of the morphology and of the pathogenicity.

TABLE 5.—Showing result of feeding naturally-infected *Glossina morsitans* on healthy monkeys.

Date	Animal	Number flies fed	Result
October 30—31, 1911	Monkey No. 96	82	Infection, human trypanosome
January 7—12, 1912	,, ,, 210	269	,, ,,
,, 16—18, 1912	,, ,, 217	200	,, ,,
March 20, 1912	,, ,, 316	101	,, ,,
,, 28, 1912	,, ,, 333	74	,, ,,

In all, 3,202 freshly-caught *Glossina morsitans* have been fed on healthy monkeys, and the human trypanosome has been isolated in 5 out of 28 experiments. Assuming that only one fly was transmitting the parasite in each instance, the ratio of flies infected, in nature, is 1 to 640, or 0·15 per cent., as compared with 3·5 per cent. amongst the bred flies which were fed on infected animals.

IV. OCCURRENCE OF THE TRYPANOSOME IN GAME

A few additional head of game have been examined, and the results are shown in Table 6.

TABLE 6.—Result of the examination of game for trypanosomes.

Animal	Number examined	No. in which trypanosomes were found in buck's blood	Number inoculations made	No. positive inoculations in which parasites were seen in buck's blood	No. positive inoculations in which no parasites were seen in buck's blood	Total number buck found infected by examination and inoculation
Zebra	2	0	1	0	0	0
Roan	3	0	1	0	0	0
Hartebeest	4	0	0	0	0	0
Waterbuck	2	1	0	0	0	1
Mpala	11	0	2	0	0	0
Bushbuck	2	0	2	0	1	1
Bushpig	2	0	0	0	0	0
Warthog	3	0	0	0	0	0
	29	1	6	0	1	2
Totals, 1st report ...	98	25	50	8	6	31
	127	26	56	8	7	33

The percentage of the local game harbouring trypanosomes may be estimated most correctly by considering only the number from which inoculations were made, namely 56. This number includes only those subinoculated animals which lived for a sufficiently long period to determine the infectability of the blood inoculated. An analysis of the inoculations reveals the following details:—

Total number of inoculations	56
Number of successful inoculations in which parasites were found in buck's peripheral blood	8
Number of successful inoculations in which *no* parasites were found in buck's peripheral blood	7
Number of unsuccessful inoculations in which parasites were found in buck's peripheral blood	5
Total number of buck found infected by direct examination and by inoculation	20

We have already pointed out that in this vicinity *Trypanosoma vivax* and *Trypanosoma nanum* are found, to both of which monkeys and rats are insusceptible. As these were the animals used for our game inoculations, it is, therefore, impossible to give an absolutely correct estimate of the percentage of game infected, but from the data given above, it is evident that the minimum is 35·7, and it is highly probable that the actual percentage is much greater. We base this opinion chiefly on the fact that infections with *Trypanosoma vivax* and *Tryanosoma nanum* appear to be of frequent occurrence in various species of game.

Each of four local goats which were examined, was found to be infected with one or other of these trypanosomes, and as goats more closely resemble game than any other variety of domestic stock in their reaction to infection, it appears justifiable to take the course of infection in them as an indication of the course pursued by similar infections in game. These goats have been under continuous observation for long periods, and, as a rule, trypanosomes were found in the peripheral blood at rare intervals only, in some cases as much as two months apart. It will be seen, therefore, that a casual examination might easily fail to reveal the presence of trypanosomes, and that inoculations into monkeys and rats would meet with no greater success. This is probably what occurs in connection with game. If sheep and goats had been available for inoculation the correct percentage of infection in game could be calculated, but this, unfortunately, has been an impossibility at Nawalia.

In addition to the seven buck and one warthog mentioned in our former report, one bushbuck has been found to harbour the human trypanosome. This parasite, therefore, has been isolated from 16 per cent. of the local game, the species implicated being waterbuck (4), hartebeest (1), mpala (2), bushbuck (1), and warthog (1).

V. COMPARISON OF THE MORPHOLOGY AND PATHOGENICITY OF THE 'HUMAN,' 'GAME,' AND 'FLY' STRAINS OF *TRYPANOSOMA RHODESIENSE*

We concluded that one of the trypanosomes isolated from game, and from naturally-infected tsetse flies was identical with the 'human strain' of *Trypanosoma rhodesiense*, as it exhibited precisely the same morphology and pathogenicity. Additional observations have strengthened this conclusion.

(1) *Morphology.*

In fresh preparations, all three strains show the same mixture of short, slowly-moving, and long, active forms, the relative numbers of which vary in the peripheral blood of any animal from day to day.

In stained preparations, it is sufficient to say that it is impossible to distinguish any one of the three strains from the others. Short forms in which the macronucleus lies actually posterior to the blepharoplast have been observed in each of the three strains.

The measurements of the three strains also show an extremely close agreement. Eleven hundred individuals of each have been measured, and the results are given in Tables 7, 8, and 9. The total number of parasites drawn from each variety of laboratory animal is the same in the case of each strain, and only twenty-five have been measured from any one preparation, as it has been found that the average length varies within wide limits, from day to day, in any given animal.

TABLE 7.—Giving details of measurement of 1,100 individuals of the 'human' strain.

Animal		Day of disease	Number measured	Length in microns		
				Average	Maximum	Minimum
Monkey	5 ...	6th	25	21·03	27·75	15·5
,,	5 ...	11th	25	19·5	26·19	13·27
,,	6 ...	8th	25	19·41	28	13·5
,,	6 ...	15th	25	26·3	31·5	19·67
,,	20 ...	9th	25	22·3	30·3	17·1
,,	20 ...	13th	25	19·97	26·25	13·25
,,	25 ...	9th	25	21·28	28·25	18
,,	25 ...	13th	25	19·57	29·75	15·25
,,	33 ...	8th	25	24·2	28·75	16·75
,,	33 ...	9th	25	20·59	29·75	15·25
,,	87 ...	11th	25	22·81	31·5	18·25
,,	87 ...	21st	25	22·41	29·25	18·5
,,	87 ...	22nd	25	19·95	27	17
Dog	244 ...	6th	25	22·26	29·25	18·75
,,	244 ...	8th	25	20·16	24·5	17·5
,,	244 ...	13th	25	21·72	31·25	18·25
,,	244 ...	14th	25	19·7	22·5	17·25
Rabbit	13 ...	4th	25	23·5	30·5	14·5
,,	13 ...	22nd	25	18·11	24·75	15·5
,,	A ...	24th	25	19·52	39·25	14·5
,,	86 ...	13th	25	21·91	29	16·75
Guinea-pig	14 ...	14th	25	21·09	30·25	17·5
,,	14 ...	20th	25	22·03	31·75	16
,,	14 ...	22nd	25	22·21	33·25	14·5
,,	139 ...	25th	25	20·66	27·25	15·75
,,	139 ...	36th	25	18·2	26·5	14
,,	139 ...	52nd	25	18·4	28	13·75
Rat	15 ...	22nd	25	20·03	25·5	15·75
,,	15 ...	26th	25	21·08	28·25	16·75
,,	16 ...	15th	25	22·98	33·25	15·75
,,	183 ...	12th	25	22·44	30·75	18·75
,,	184 ...	12th	25	22·12	31·25	18
,,	184 ...	14th	25	19·64	31	14·25
,,	184 ...	20th	25	22·17	27·5	17
,,	184 ...	28th	25	20·59	30	16·75
,,	208 ...	10th	25	19·32	23·25	16·75
,,	208 ...	20th	25	19·69	24·5	17
,,	212 ...	6th	25	23·33	31	18·75
,,	212 ...	7th	25	20·88	32·5	15·5
,,	212 ...	16th	25	18·66	22·5	13·75
Mouse	27 ...	12th	25	20·95	26·75	18·5
,,	28 ...	6th	25	19·94	23	17·25
,,	91 ...	6th	25	23·94	27·25	18·5
,,	91 ...	10th	25	28·65	33	21·5
			1,100	21·25	39·25	13·25

TABLE 8.—Giving details of measurement of 1,100 individuals of 'game' strain.

Animal		Day of disease	Number measured	Length in microns		
				Average	Maximum	Minimum
Monkey	71 ...	7th	25	24·79	32·9	17
,,	71 ...	9th	25	19·84	23·8	15·3
,,	99 ...	38th	25	26·36	34·25	19
,,	120 ...	8th	25	20·02	23·5	18
,,	120 ...	11th	25	21·9	29·25	17·25
,,	120 ...	13th	25	17·4	20	15
,,	130 ...	8th	25	25·97	35·5	19
,,	130 ...	11th	25	22·05	30·5	16·25
,,	199 ...	5th	25	22·47	25·75	15·75
,,	199 ...	7th	25	23·6	32·25	16·75
,,	201 ...	7th	25	23·4	31	17·75
,,	201 ...	8th	25	21·62	25·5	17·5
,,	201 ...	9th	25	19·58	21·75	17·25
Dog	Native ...	?	25	19·1	26	15·5
,,	262 ...	5th	25	21·69	25·75	18·5
,,	262 ...	7th	25	19·13	23·5	13·5
,,	262 ...	11th	25	18·34	22·5	16·25
Rabbit	79 ...	11th	25	20·02	29	15·2
,,	249 ...	9th	25	16·18	19·5	13·75
,,	249 ...	13th	25	22·29	32	15·25
,,	249 ...	13th	25	20·91	28·5	15·75
Guinea-pig	251 ...	10th	25	20·87	33·25	15·25
,,	251 ...	11th	25	22·87	34·5	15·75
,,	251 ...	13th	25	23·11	33·75	15
,,	251 ...	15th	25	23·5	32·25	14·75
,,	251 ...	17th	25	24·09	34·25	13·75
,,	251 ...	21st	25	21·67	29·75	14·5
Rat	81 ...	14th	25	21·05	31·5	16
,,	128 ...	20th	25	20·25	21·75	17·5
,,	128 ...	22nd	25	20·3	23·75	16
,,	129 ...	?	25	20·9	28	16·25
,,	157 ...	21st	25	25·65	30·5	14·5
,,	157 ...	42nd	25	19·27	21·5	16·75
,,	157 ...	49th	25	22·8	32·5	16·25
,,	195 ...	26th	25	21·8	35	16·5
,,	195 ...	36th	25	19	24·5	17
,,	213 ...	17th	25	17·38	19	14·5
,,	213 ...	26th	25	22·31	34·25	17·5
,,	221 ...	7th	25	18·91	23	16·5
,,	221 ...	14th	25	21·91	35·5	11·75
Mouse	176 ...	9th	25	20·13	26·5	17·5
,,	176 ...	14th	25	20·99	26·5	16·75
,,	178 ...	6th	25	22·89	29·5	17·25
,,	178 ...	7th	25	21·6	27	16·5
			1,100	21·38	35·5	11·75

TABLE 9.—Giving details of measurement of 1,100 individuals of 'fly' strain.

Animal		Day of disease	Number measured	Length in microns		
				Average	Maximum	Minimum
Monkey	96 ...	7th	25	25·7	32	16
,,	96 ...	8th	25	24·8	33·5	16·5
,,	96 ...	9th	25	25·6	36·25	16
,,	96 ...	10th	25	23·3	30·75	15·75
,,	96 ...	11th	25	22·6	31	15·25
,,	96 ...	14th	25	20·3	23·5	16·5
,,	114 ...	27th	25	22	28	15·25
,,	114 ...	32nd	25	20·9	25·25	18
,,	114 ...	41st	25	20·8	30·75	15·25
,,	210 ...	8th	25	24·66	30·5	17·5
,,	210 ...	10th	25	20·29	23·25	18·25
,,	217 ...	9th	25	26·03	30·75	22
,,	316 ...	9th	25	24·69	32·25	17·5
Dog	235 ...	5th	25	26·7	33	19
,,	235 ...	7th	25	21·4	28	19
,,	235 ...	9th	25	20	28	18·25
,,	235 ...	13th	25	20	21·25	18·5
Rabbit	245 ...	7th	25	23·5	29·5	16·5
,,	245 ...	8th	25	20	28	14·5
,,	245 ...	9th	25	18·75	27·75	16·25
,,	245 ...	13th	25	22·84	30	17
Guinea-pig	246 ...	13th	25	19·87	23·5	16·7
,,	246 ...	15th	25	20·88	26	16·25
,,	246 ...	18th	25	17·63	21·5	13
,,	246 ...	19th	25	19	27·25	16·5
,,	246 ...	20th	25	18·95	25·25	14·25
,,	246 ...	21st	25	21	27·5	15·25
Rat	103 ...	4th	25	24·1	30	17
,,	103 ...	5th	25	20·3	30	16·5
,,	103 ...	8th	25	18·8	30·75	14·5
,,	218 ...	6th	25	19·47	24·75	16·5
,,	218 ...	9th	25	19·3	29	14·5
,,	218 ...	14th	25	20·1	22·5	17
,,	218 ...	16th	25	19·41	26·75	16
,,	218 ...	18th	25	22	30·5	18
,,	229 ...	6th	25	24·55	29·5	19
,,	229 ...	8th	25	21·09	29·25	17
,,	229 ...	9th	25	19·5	21·75	17·5
,,	229 ...	13th	25	22·3	29·5	18·5
,,	229 ...	15th	25	20·31	22·75	17
Mouse	247 ...	4th	25	23·1	29·5	19·5
,,	247 ...	6th	25	23·66	29·5	19·25
,,	247 ...	9th	25	22·6	34	18·75
,,	247 ...	14th	25	20·91	25·25	17·25
			1,100	21·67	36·25	13

TABLE 10.—Comparison of the measurements of the 'human,' 'game,' and 'fly' strains.

Strain	Length in microns		
	Average	Maximum	Minimum
'Human'	21·25	39	13·25
'Game'	21·38	35·5	11·75
'Fly'	21·67	36·25	13

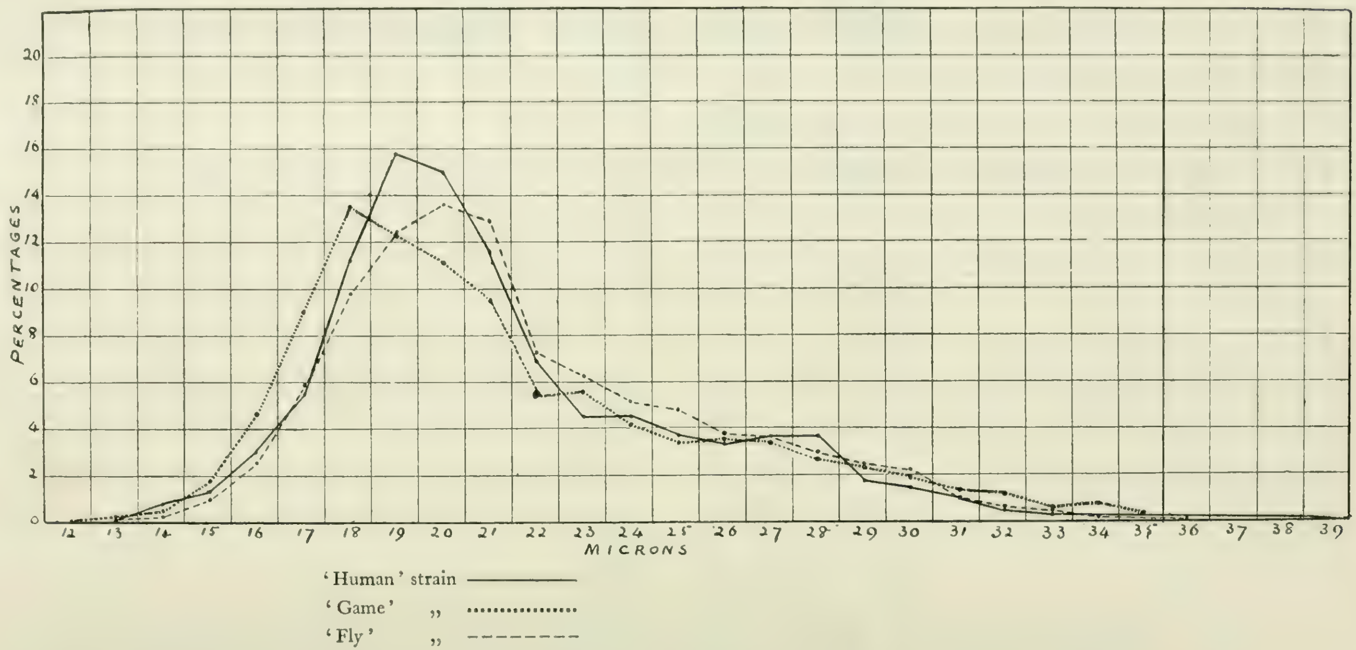
The similarity in the measurements is, perhaps, best appreciated by a glance at the curves obtained by plotting out the distribution of the various lengths of the parasites, expressed in percentages of the total numbers measured.

A comparison of the percentages of 'short and stumpy,' 'intermediate' and 'long' forms is also of interest.

TABLE 11.—Comparison of percentages of 'short and stumpy,' 'intermediate,' and 'long' forms of the 'human,' 'game,' and 'fly' strains.

Strain	Short and stumpy forms 11-21μ	Intermediate forms 22-24μ	Long forms 25-39μ
'Human'	64·78	15·98	19·14
'Game'	62·87	15·34	21·56
'Fly'	58·68	18·81	22·41

CHART I. Comparison of curves of the 'human,' 'game,' and 'fly' strains obtained by plotting out the distribution of the various lengths of the parasites, expressed in percentages of the total numbers measured (1,100 of each strain).



(2) *Pathogenicity.*

The pathogenicity of the three strains is synopsised in Table 12.

TABLE 12.—Comparison of pathogenicity of the 'human,' 'game,' and 'fly' strains.

Animal	'Human' strain			'Game' strain			'Fly' strain		
	No.	Incubation days	Duration days	No.	Incubation days	Duration days	No.	Incubation days	Duration days
Monkey ...	12	2-7	4-42	14	4-11	7-40	6	4-6	9-54
Dog ...	1	5	26	1	5	25	1	5	26
Rabbit ...	3	4	16-61	1	4	30	1	6	19
Guinea-pig	2	12-19	65-81	2	10-11	53 one alive after 66 days	1	11	alive after 72 days
Rat ...	16	2-8	15-82	10	3-6	11-43	4	3-5	24-48
Mouse ...	4	4	15-63	2	4-5	48-51	1	4	alive after 72 days

As a result of these observations, we are forced to conclude that the 'game' and 'fly' strains are identical with the human trypanosome.

VI. SUMMARY

(1) *Trypanosoma rhodesiense* is transmitted by *Glossina morsitans.*

(2) *Glossina morsitans* transmits *Trypanosoma rhodesiense* in nature.

(3) A considerable percentage of the local game (16) is infected with *Trypanosoma rhodesiense.*

NAWALIA, N. RHODESIA
April 12, 1912